Title: NASA-CCNY Center for Advanced Batteries for Space (ABS)
Institution: City College of New York
City/State: New York, New York
PI: Robert Messinger

Summary: Overview: A joint research and education center will be established between The City College of New York (CCNY), NASA's Jet Propulsion Lab (JPL), and Northeastern University which will form a highly collaborative research network in electrochemical energy storage and train a diverse STEM workforce through a multi-faceted student internship program. CCNY brings extensive expertise in novel battery development, minority student training and recruitment, and management. Northeastern University brings experience in advanced battery characterization, particularly at national laboratories, while JPL brings deep knowledge of batteries for spaceflight as well as facilities that permit device testing under the extreme conditions encountered in space.

Research Focus: The overarching research objective is to develop novel battery technologies designed to significantly enhance the scope and ambition of future NASA planetary science missions. Such electrochemical energy storage devices, which power robotic spacecraft, must operate under extreme temperatures and radiation exposure. NASA issued a report in Dec. 2017, "Energy Storage Technologies for Future Planetary Science Missions," which outlined challenges and strict specifications in energy density, power density, cycle life, and safety that far exceed those of state-of-the-art lithium-ion batteries. Research efforts seek to develop batteries aimed at meeting such targets by combining high-energy-density aluminum and zinc metal electrodes with ionic liquid electrolytes that exhibit significantly larger temperature windows, greater radiation stability, and vanishingly low vapor pressures compared to conventional organic electrolytes. Novel engineering techniques (e.g., 3D printed metal electrodes) will also be used to enhance battery performance and advanced spectroscopic, diffraction, and imaging characterization methods will result in new scientific understanding of metal-ionic liquid electrochemical systems. Battery prototypes will be tested at NASA's JPL under the extreme temperatures and radiation exposure encountered during planetary science missions.

Educational Focus: The overarching educational objective is to train a highly skilled, diverse STEM workforce from the undergraduate to doctoral levels specialized in electrochemical energy storage, an area of strategic importance for NASA and the Nation. To do so, a multi-faceted student internship program will be established wherein students traditionally underrepresented in STEM disciplines will perform prolonged internships that integrate education and laboratory research at NASA's JPL, CCNY, and Northeastern University. Student programs include doctoral and undergraduate internships in JPL, a student exchange program between CCNY and Northeastern University, and an undergraduate summer research program at CCNY drawing from local regional and community colleges, including Hostos and Bronx

Community Colleges. Students will gain technical expertise in electrochemical engineering, materials science, physical chemistry, and engineering design. In addition, students will be trained in professional development skills, including written and oral communication,
teamwork, conflict management, and networking, to better prepare them for today's working
environments.

Significance to NASA: The Center's efforts will impact NASA's Planetary Science Division and Science Missions Directorate by (i) developing high-energy-density, radiation tolerant, and safe batteries that operate at extreme temperatures, thereby enabling significantly improved robotic spacecraft and consequently new planetary science mission concepts, while (ii) developing a diverse STEM workforce poised to tackle challenging problems in energy and engineering specialized in areas of strategic important to NASA and